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The use of quantitative methods in planning national cancer control programmes*

A WHO MEETING[1]

There is a strong need to allocate in a rational and cost-effective way the available resources for cancer control in countries. Continuation of current priorities in resource allocation can only lead to unnecessarily high incidence, morbidity and mortality from cancer. Two cancer control models for cost-effectiveness, which were developed by WHO to help Member States set priorities in national cancer control programmes, have been tested and found useful. This article discusses cost-effectiveness analysis and describes the two models and their application in countries.

INTRODUCTION

Cancer is one of the important health problems in the world, causing about 4.3 million deaths each year. Its impact in developed countries is well known; it strikes about one fourth of all people, about one half of all families, and is the second most common cause of death. Less well known is that the majority of all cancer deaths, about 2.3 million, occur in developing countries. For those who survive the first five years of life, cancer is one of the three most common causes of death in both developed and developing countries (*1*, *2*).

There is an urgent need for right priorities and strategies in cancer control (*3*). Unfortunately, the cancer problem is increasing. A recent WHO analysis of cancer in 28 developed countries indicates that the age-adjusted cancer death rate between 1960 and 1980 increased by 19% in men (*4*). Cancer mortality is also increasing in the developing countries. For example, in Shanghai County, China, cancer was the sixth most common cause of death in 1960–62, but became number one by 1978–80 (*5*). The increase has two main causes: aging of the population as programmes to control other diseases take effect, and increased use of tobacco. In the developing countries, therefore, cancer rates can be expected to rise further.

The knowledge needed to control cancer is now available because past research has provided information about the causes of many cancers, the incidence rates in various populations, the specific groups with a high risk of developing particular cancers, and about the prevention, screening, diagnosis, treatment, rehabilitation, and pain control of specific cancers. Overall, more than a third of all cancers can be prevented, and with proper early detection and treatment about a third of all patients who get cancer can be cured; cases that cannot be prevented or cured can be relieved of pain (*3*).

Unfortunately there are not enough resources to undertake all the possible cancer control activities. All countries, both developed and developing, have limits on the money, trained people, equipment, and facilities needed to control cancer. It is essential that these resources should be used as efficiently as possible. The effectiveness and cost-effectiveness of different activities must be determined, and priority must be given to those that will minimize the incidence and mortality of cancer with the available resources. This requires the use of formal planning methods.

Formal planning methods are needed because of the complexity of the cancer control problem. In each country, there are a multitude of cancers, each with its own age-specific incidence rates and mortality rates, risk factors, and high-risk groups. For each cancer there are many types of programmes that can be applied—including prevention, screening, early detection, diagnosis, treatment, surveillance, rehabilitation, and pain control. For each type of programme, there are dozens of specific activities, involving specific subpopulations, age groups, frequencies of examinations, choices of diagnostic tests, types of treatments, and other factors. In all, there may be hundreds of possible activities for cancer con-

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[1] The names of the participants are given on pages 692–693.

trol in a country. It is therefore impossible for experts and planners, using their expert judgement alone, to determine which activities are most efficient in controlling cancer in their country.

Currently, decisions concerned with resource allocation are largely governed by such influences as the desire of leading cancer clinicians to continue strengthening their own therapeutic approaches and centres, the emphasis by pressure groups on certain occupational cancers, the demand by relatives of cancer patients for more resources for therapies, the promises during fund-raising and the public's expectations for rapid results in research — all these instead of the implementation of existing knowledge in a rational way.

In the absence of formal planning methods, there is a strong temptation for developing countries to mimic programmes advocated in developed countries, where traditionally priority has been given to therapeutic services. Adopting such a strategy could lead to a disastrously inefficient use of resources, and an unnecessarily high incidence of morbidity and mortality from cancer.

COST-EFFECTIVENESS ANALYSIS

Although cost-effectiveness evaluations of health care have been conducted for many years (*6–8*), the few that were concerned with cancer control programmes tended to analyse individual cancer-specific questions rather than the total use of the available resources for cancer control, and led to no major resource reallocations. The purpose of a formal cost-effectiveness analysis is to help planners use the available information in order to make a reliable estimate of how different cancer control activities affect the incidence, mortality, and cost of cancer. These estimates can then be used to create a comprehensive cancer control programme that will improve the health and welfare of a population with the available resources.

Cost-effectiveness analysis attempts to determine how the available resources can be used to achieve an objective (such as reducing cancer incidence, the suffering, or mortality). It accomplishes this by explicitly estimating how specific activities contribute to that objective, and by applying economic principles to choose the combination of activities that will most effectively achieve the objective using the available resources.

Briefly, the seven main steps of cost-effectiveness analysis and their principles are as follows:

(1) Define the *objective*. The objective of a cancer control programme might be a combination of a reduction in new cancer cases, reduction in pain among cancer patients, and reduction in cancer deaths. The objective should be stated explicitly in terms of the expected results from the cancer control activities.

(2) Identify *activities* for achieving the objective, e.g., antitobacco education in schools, cervical cancer screening, surgery for breast cancer, post-treatment surveillance, and pain control. When identifying activities it is important that all the relevant options be included. In particular, it is important not only to be creative in listing possible activities, but also to explore variations of each activity that might affect its effectiveness and cost. For example, individual cervical cancer screening programmes could modify the age groups or the frequency of screening, or direct the screening to mainly high-risk groups.

(3) Estimate the *effectiveness* of each activity (and its variations) in achieving the objective.

(4) Estimate the *cost* of each activity and its variations. To the greatest extent possible, all the relevant costs (to the cancer control programme, to the health service, and to the individual and his/her family) should be included.

(5) Estimate the *marginal return* of each activity compared with the alternatives. The marginal return of an activity is the additional amount of benefit achieved by the activity per additional unit of resources consumed by the activity; this should be compared with the marginal returns of appropriate alternatives. The alternatives should include variations of the activity, as well as other types of activities.

(6) Give *priority* to activities that have the highest marginal return. In general, when all the resources have been allocated and the priorities are set properly, all the chosen activities will have approximately the same return. If the marginal returns of two activities are not equal, resources can be taken from the activity with lower return and put into the activity with the higher return, to achieve a greater amount of benefit at no increase in cost (or possibly a decrease in cost).

(7) Describe explicitly the *assumptions* and *value judgements* that are necessary when estimating the effectiveness and costs of a control activity and when setting priorities. In addition, the effect of variations in assumptions and judgements on the results should be explored (sensitivity analysis).

In theory, these principles can be applied by answering the following questions for each possible activity that might be included in a cancer control programme (for convenience, let us suppose the activities are A, B, C, etc.):

— If, say, $1000 is taken from the cost of the activity, what would the effect be?

—If $1000 is added to the cost of the activity, what would the effect be?

If the least loss of benefit is in, say, activity A, and the greatest gain in benefit is in activity B, and if B's gain is greater than A's loss, $1000 should be switched from A to B. For each variation or modified activity (e.g., A1 and B1), the questions would be asked again, and the process repeated until no further switches could be made that would produce an overall gain in benefit.

The method of cost-effectiveness analysis

The principles of cost-effectiveness analysis have been known for a long time. The difficulty is to apply them in actual settings. This requires some information and a method for estimating both the effectiveness and the costs of different cancer control programmes (steps 3 and 4, given above) so that their marginal returns can be estimated (step 5) and priorities can be set (step 6).

Empirical research. Ideally, the effectiveness and costs of all the possible activities (and their variations) would be determined by conducting empirical research, such as randomized controlled trials. Desirable as this may be, the available data will remain incomplete because it will not be possible to conduct all the research required. The main problem is that there are far too many activities to be evaluated. Furthermore, some of the most important cancer control research (that dealing with primary and secondary prevention) is extremely expensive, requires huge populations, and takes decades; it is simply not feasible.

Subjective judgements. To set priorities, cancer control planners currently have to rely on their own subjective judgements and those of experts. Because of the complexity of the problems in planning, it is extremely difficult to plan accurately. For example, answers to the following two main questions involve subjective judgements: what are the activities to be selected for comparison from the multitude of activities, and what are the assumed effects in the absence of good information, e.g., empirical research results?

Quantitative methods. Quantitative methods incorporating the available epidemiological data, the available research, and expert judgements have been developed for applying the principles of cost-effectiveness analysis and setting priorities. These methods (or "models") enable planners to separate the planning problem into parts, use the existing information to analyse each part, reconstruct the parts to estimate the impact of different cancer control activities on a population over a period of time, and compare the activities for the setting of priorities. The use of quantitative methods reduces, but does not eliminate the need for judgements. Quantitative methods provide a structure and language for thinking.

CANCER CONTROL MODELS

Cancer control models vary in their scope, complexity, data requirements, and capabilities. There are two basic types. The first focuses on a specific cancer or a specific type of activity, such as cervical cancer screening, and is useful for evaluating the cost-effectiveness of different variations of the activity (e.g., the frequency of screening, the choice of tests for screening, or the ages at which screening should begin or end). The other, called a global cancer control model, encompasses a broad range of cancers and cancer control activities, and is more powerful for developing national cancer control programmes.

Examples of cost-effectiveness models in cancer

Cancer-specific models. Several cancer-specific models have been used to help plan national cancer control activities. For example, in England and Wales, a model of cervical cancer screening developed by Knox has been used to help determine the age groups for and frequency of cervical cancer screening through the National Health Service (*9*). A model by Yu and colleagues, based on Knox's model, has been used in Canada (*10*), and a model by Eddy has been used in the USA to analyse the same question (*11*). All these models focus on the impact of cancer screening on an individual. Cervical cancer screening models that estimate the impact of various programmes on a population have also been developed (*12*, *13*).

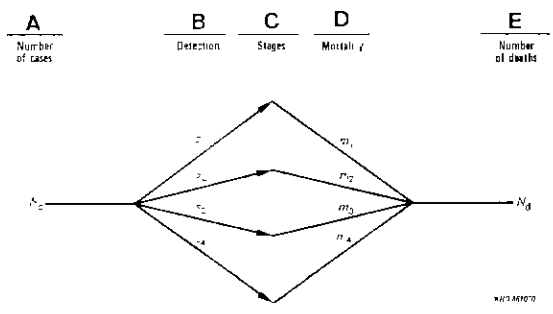

Fig. 1. Profile of cancer epidemiology (see text for details).

*Global cancer control models: CANCER*PLAN.* Two global cancer control models have been developed by the WHO Collaborating Centre for Research in Cancer Policy at Duke University in the USA, in collaboration with WHO. One, called CANCER*PLAN, was first applied in Colombo, Sri Lanka, to evaluate strategies for oral cancer control in developing countries (*14*, *15*) and to help set priorities for national cancer control programmes.

The structure of this model is very simple (Fig. 1), and represents the progression, or profile, of a cancer from its initiation (point A) and detection (point B) up to death (point E); the branches in between represent the various stages in which the cancers are detected (point C) and the effectiveness of treatment for each stage (point D). The model indicates the number of new cases of the cancer (N_c), the proportion of cancers detected in each stage (s_1), the long-term mortality rates after treatment for each stage (m_1), and the number of deaths from the cancer (N_d). The effect of various cancer control activities can be calculated by using this profile framework. For example, primary prevention affects the number of new cases (N_c), screening affects the proportion of cancers found in each stage (s_1) (and may also affect the mortality rate for each stage (m_1)), and treatment affects the long-term mortality of cancers detected in various stages (m_1). The effect of any activity or combination of activities on long-term incidence and mortality can be calculated by inserting the appropriate numbers in the framework, and using formulas based on the framework; the formulas essentially multiply the numbers across the framework. The model can be extended to analyse programmes that affect various risk groups and subpopulations, and to address cancer control activities that affect the quality of life (e.g., pain control) (*15*). An application of the model is described below.

This model was purposely kept simple so that it could be summarized on a single sheet of paper and the calculations could be made with a hand-held calculator. A drawback of the model is that it does not explicitly analyse the impact of different cancer control activities as a function of time. The results of the model describe what can be expected to occur after the cancer control activity has been in force for a long enough time for all the effects to have occurred (a "steady state").

Because it is impossible to predict all future trends, the results of the model should not be considered as predictions. Furthermore, the length of time required to reach a "steady state" depends on the cancer control activity; a new treatment programme could reach its full effect almost immediately, whereas an antitobacco education programme for schoolchildren would not reach its full effect for decades. While it is possible to estimate the approximate time required for each activity to reach its full effect, this time is not calculated explicitly by the model, and the model does not estimate the impact of the activity in the intervening years. Thus CANCER*PLAN cannot predict the effects of a cancer control programme on a year-by-year basis.

*Global cancer control models: CAN*TROL.* For more detailed planning that requires estimating the impact of cancer control activities year by year, a more powerful model called CAN*TROL (a computer model for designing CANcer conTROL strategies) has been created (*16*). CAN*TROL has several components. A population model starts with data on the current population, registers the births and deaths for each year, and calculates the number of people in the population, by sex and five-year age group, for each year in the future. A cancer incidence model estimates the number of cases of each cancer that will occur in the population, for each sex and five-year age group. The third component (concerned with screening and detection) estimates the proportions of each cancer found in particular stages, by age and sex, in a fashion quite similar to the framework illustrated in Fig. 1. A treatment and support model calculates the survival of patients treated in various stages; this component is more complicated than the framework shown in Fig. 1 as it explicitly incorporates the probability of survival as a function of time after diagnosis and treatment; it also includes various rehabilitation and support programmes (e.g., pain control). The last component calculates the number of deaths from causes other than cancer.

CAN*TROL can be used to calculate the impact of different combinations of prevention, screening and early detection, treatment, and support activities on the cancer incidence, mortality, quality-of-life measures, and cost for any year in the future. With the model, it is possible to estimate the effectiveness, cost, cost-effectiveness, and marginal return of various combinations of cancer control activities, as needed to accomplish the steps of the cost-effectiveness analysis described above. This model has a number of additional features that make it powerful for estimating the impact of cancer control programmes in realistic settings. For example:

(1) Virtually any population can be described; examples are the populations of France or the USSR; people over 20 years in Shanghai County, China; Hispanic Americans living in Los Angeles, USA; or the employees of a particular corporation.

(2) The population can be partitioned into any number of subpopulations, which may be the targets of different cancer control programmes. Subpopulations can be distinguished from the total population by differences in size, relative risk,

proportions in different stages, survival rates, and costs. Definition of subpopulations is especially useful for addressing primary prevention programmes for people exposed to particular carcinogens (e.g., smokers, asbestos workers, sunbathers).

(3) It can incorporate any cancer for which there are data on incidence rates, proportions in different stages, and survival rates.

(4) For any particular cancer, the model can calculate simultaneously the effects of any number and combination of activities.

(5) For any particular cancer control activity, and any subpopulation, it is possible to designate specific periods of time when the activity will be conducted (e.g., 1987 through 1993). Any number of periods can be defined.

(6) For any activity, subpopulation, and period, it is possible to designate specific age groups (e.g., all women between 40 and 65) that will be the target of the activity. Any number of age groups can be defined.

(7) Within any subpopulation, period, and age group, it is possible to specify the proportion of the people in that target group who will actually receive the cancer control activity. Furthermore, this proportion can be made a function of time, to evaluate the gradual diffusion of a cancer control activity.

(8) It separately analyses deaths from cardiovascular disease and deaths from noncardiovascular disease, to enable investigation of the impact of trends in cardiovascular mortality rates.

(9) It is possible to specify future trends in cardiovascular mortality, mortality from other causes, births, and incidence rates for any cancer, and the effectiveness of treatment. These trends can be specified by projecting observations of past trends, or by specifying parameters for a variety of functions.

(10) For a primary prevention activity, it is possible to identify a particular risk behaviour or exposure to a carcinogen, calculate the relative risk of people in the high-risk group, calculate the maximum potential reduction in risk that would occur if the risk behaviour or exposure were eliminated, specify the proportion of that maximum reduction that is actually expected to occur if exposure is ended, and specify the delay in expression of the reduction.

(11) It is possible to define the population as a cohort of specific people who will be followed through time. A cohort is distinguished by the fact that once defined, the individuals will not change (e.g., no births).

(12) For primary prevention programmes CAN*TROL can calculate how the cancer control activity will change the number of people with the risk factor (e.g., the number of smokers).

(13) If a particular cancer control activity affects more than one cancer, the combined effects on incidence, prevalence, mortality, prevalence of risk factors, and cost can be calculated.

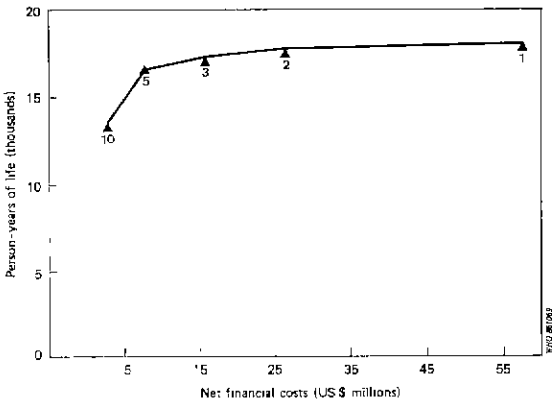

Fig. 2. Relationship between person-years of life saved in a cohort of 100 000 20-year-old women and the current value of net financial costs, for five different screening frequencies (every 1, 2, 3, 5 and 10 years). The net financial costs include the costs of screening, workups, initial care and terminal care, discounted at 3% (based on data in reference *16*).

Applications of cost-effectiveness models

Four examples illustrating application of the principles of cost-effectiveness analysis and the use of specific models to help evaluate cancer control activities are described below.

Cervical cancer screening. A model developed at the WHO Collaborating Centre for Research in Cancer Policy (Duke University) has been used in the USA to estimate the effect of screening for cervical cancer at different frequencies. For this analysis, the measure of effectiveness was the increase in person-years of life caused by the screening activity, and the measure of resources was the present value of financial cost.[a] In this case the model estimated the effect of different frequencies on person-years of life and financial costs in a cohort of 100 000 women who began screening at age 20. The results are shown in Fig. 2.

A recent independent review of data from population-based cervical cancer screening programmes in Europe and North America (*17*) has validated the results of this model. Predictions made

[a] Present value is a measure of the value today of a series of costs that will occur in the future. It takes into account discount rates and can be thought of as the amount of money that would have to be in a bank today to cover all future costs related to an activity when it is carried out in the future.

by the model almost 10 years ago match the empirical observations within 2%.

This example illustrates well the principles of cost-effectiveness analysis, especially the importance of examining the yield or marginal return of different variations of cancer control activities (e.g., different screening frequencies). If annual screening is compared with no screening at all, the increase in person-years of life is about 18 158 years, at a cost of about US$ 57.6 million,[b] giving a cost per person-year of life of about US$ 3172. However, an examination of the marginal cost-effectiveness of an annual screening frequency compared with screening every two, three or five years, reveals a different picture. For example, compared with a two-year frequency, an annual frequency adds only an additional 329 person-years of life, at an additional cost of approximately US$ 31.4 million, causing the annual frequency to have a yield or marginal return (compared with the two-year frequency) of one person-year of life for about US$ 95 446.

This example illustrates how the use of cost-effectiveness analysis and careful setting of priorities can improve effectiveness without increasing the cost. For example, suppose US$ 10 million were available to screen 100 000 women for cervical cancer. If screening were recommended every year, it would be possible to screen about one sixth of the population at this frequency, and the effectiveness would be to add about 3150 person-years of life. The other five sixths of women would receive no screening at all and there would be no increase in life in that group. On the other hand, if the money were used to screen each woman every five years, the entire population could be screened for about $7.7 million, and the increase in person-years of life would be about 16 700. The total effectiveness of that programme would be about *five* times greater and at a lower cost (a saving of $2.3 million).

Resource planning in Finland. A resource planning model has been used in Finland to help plan cancer control programmes. The number of new cases of cancer expected in the year 2000 were predicted from data from the Finnish Cancer Registry, using models that take into account the trends in the incidence of cancer by date, period and birth cohort, and population forecasts in Finland. With additional modelling, forecasts have been made to help plan oncology services. For example, on the basis of the predicted number of new cancer cases and detailed analysis of a representative sample of hospital records, estimates have been made of the expected use of services and the need for resources in the year 2000 (*18–20*). The results are shown in Table 1.

Table 1. Expected use of services and need for resources in the year 2000, compared with 1979, in the Finnish cancer control programme[a]

Indicator	1979	2000
New cases	15 913	20 180
Prevalent cases	57 244	160 000
Hospital days	917 000	1 319 400
Outpatient visits	284 900	425 100
Hospital beds	2 790	4 020
Physicians	330	480
Direct cost (US$)	74 000 000	108 000 000

[a] Based on data in references *18–20*.

Cancer control in India. In collaboration with the Ministry of Health, India, and the Indian Council of Medical Research, CANCER*PLAN has also been used in India to help analyse five activities for controlling the two most common cancers in that country (cervix uteri and mouth cancers). A representative population of one million people in the region of Bangalore was used for the analysis. At present about 25% of this population have access to both surgery and radiation therapy in a cancer centre or medical school, about 25% have access only to surgery, and about 50% do not have access to any care at all. Five control activities for the two cancers were considered: (1) provide radiation therapy to the 25% of the population that currently has access to surgery, but not to radiation therapy; (2) provide both surgery and radiation therapy to the 50% of the population that currently does not have access to any treatment at all; (3) screen for oral cancer; (4) screen for cervical cancer; and (5) implement a pain control programme for all patients dying of cancer.

The results of the analysis are summarized in Table 2, in which for each programme the first four columns give the decrease in the number of cases of invasive cancer that occur, the increase in the number of patients cured, the number of terminal cancer patients given pain control, and the net annual cost of providing the programme to this population. A more complete description of the analysis, results and interpretation are given elsewhere.[c]

Cancer control in Chile. CAN*TROL has been applied to help analyse cancer control activities in

[b] This example assumes a Pap smear cost of $20 in the USA; the cost will be far lower in many other countries

[c] EDDY, D. M. *Priorities for cancer control in India* (unpublished WHO report, SEA/CAN/64, 1985).

Table 2. Use of the CANCER*PLAN model in India[a]

Strategies	No. of cases prevented	No. of deaths prevented	No. of people having pain control[b]	Net annual cost[c] (US$)	Time to have full effect (years)
Radiotherapy	0	15	15	15 000	1–5
Surgery and radiotherapy	0	65	65	80 000	1–5
Screening for oral cancer	60	33[d]	33[d]	20 000	5–10
Screening for cervical cancer	80	44[d]	44[d]	15 000	5–10
Pain control	0	0	7500	2500	1

[a] Another application of CANCER*PLAN, to evaluate activities for controlling oral cancer in developing countries, has been published (*14, 15*).

[b] Number of people in whom the pain of terminal cancer is reduced or eliminated. The first four entries show the number of patients whose pain was eliminated as a result of cure; the last entry shows the number of patients with terminal cancer who will receive pain control through the designated programme.

[c] For treatment and pain control, the net cost is the cost of these programmes only. For screening, the net costs include the cost of the screening examinations and workups, as well as any savings in treatment cost due to earlier detection.

[d] The main objective of screening for oral and cervical cancers is to find lesions before they become invasive cancers. Because the cure rates of pre-invasive lesions for these two cancers are virtually 100%, screening has the additional effects of increasing the number of patients cured, and of decreasing the number of people who will suffer the pain of terminal cancer.

Table 3. Use of the CAN*TROL model in Chile

Programme	Year	Incidence		Mortality		Cost (US$ 1000)		
		Number expected[a]	Change[b]	Number expected[a]	Change[b]	Programme	Treatment	Total
Treatment of lung cancer	1995	1295	0	1270	−93	0	950	950
Treatment of cervical cancer	1995	2302	0	2109	−1150	0	2369	2369
Screening for cervical cancer (20–60-year age group)	1995	2302	0	959	−306	1010	−339	671
Screening for cervical cancer (35–60-year age group)	1995	2302	0	959	−251	490	−279	211
Breast cancer chemotherapy	1995	1139	0	907	−30	0	4442	4442
Antismoking education in schools	2040	3186	−336	2915	−305	1442	−370	1072

[a] The expected number of cases (incidence) or deaths (mortality), in the absence of the programme.

[b] The change in the number of cases or deaths caused by the programme

Chile.[d] For example, measures of effectiveness and cost were calculated for the following activities:

—current treatment for lung cancer (all stages);
—current treatment for cervical cancer (all stages);
—screening of 75% of women aged 20 to 60 years for cervical cancer with Pap smears every five years;
—screening of 75% of women aged 35 to 60 years for cervical cancer with Pap smears every five years;
—chemotherapy for late-stage breast cancer;
—school-based antismoking education for young men aged 15 to 20 years.

Table 3 gives the expected effects of each activity on (1) the number of new cases of the pertinent cancer (incidence); (2) the number of deaths (mortality); and

[d] EDDY, D. M. *Priorities for cancer control in Chile* (unpublished WHO report, HQ/CAN, 1985).

(3) the cost of the activity, the cost of treatment, and total costs. Because different cancer control programmes require different lengths of time to take full effect, the effects were calculated for each year in the future. The results in Table 3 show the effects of each activity after its impact has been fully expressed. For the first five programmes, the effects are reported for 1995, assuming each of the programmes has been in effect for 10 years. For the last three programmes, the effects are reported for the year 2040. All costs are reported in US$ (1985 rates). The results in Table 3 show the expected effects of the designated activities compared with the status quo.

The results in Table 3 also indicate the use of CAN*TROL to estimate how variations in a cancer control activity can affect its marginal return. A comparison of the two cervical cancer screening programmes indicates that the average cost-effectiveness of starting screening at age 35 (measured as the cost of decreasing mortality by one, after 10 years of screening) is US$ 840. The average cost-effectiveness of starting screening at age 20 is $2193. However, the *marginal* cost-effectiveness of achieving an additional reduction in mortality by screening at age 20 instead of age 35, which is found by comparing the *difference* in reduction in deaths (306 – 251 = 55) with the additional cost ($671 000 – 211 000 = 460 000), is $8364. When applying the principles of cost-effectiveness to set priorities, it is the marginal returns of different activities that should be compared.

The model forming the core of CAN*TROL has been adapted by the US National Cancer Institute (NCI) for its own use in planning the National Cancer Program for the Year 2000 (*21*, *22*). CAN*TROL itself will be made available through the NCI to States to help set priorities for statewide cancer control programmes.

NATIONAL CANCER CONTROL PROGRAMMES

Cost-effectiveness analysis is only now beginning to be used formally to plan national cancer control activities. It is important to emphasize that whatever the methods used to estimate the effectiveness and cost of different activities, the principles of cost-effectiveness analysis (given above) should be applied to set priorities and design a coordinated cancer control programme.

Many countries have made commitments to the planning of national cancer control programmes. In Chile a national cancer control programme has been created, under the leadership of the Ministry of Health, and priority activities include antismoking campaigns and cervical cancer screening. In India a national cancer control programme has been developed by the Ministry of Health, with research and planning support from the Indian Council of Medical Research; pilot projects have been planned for cervical cancer screening, antitobacco education, and oral cancer screening. Because cancer is the leading cause of death in Japan, the government has created a Cabinet Council for Cancer Control with responsibility to design a comprehensive 10-year strategy for cancer control. Sweden's National Board of Health and Welfare has issued guidelines for the planning of clinical oncology and established regional oncology centres to maintain tumour registries, to initiate cancer care programmes, and to coordinate resources for cancer care at local and regional levels. In the USA, the cancer control programme in the National Cancer Institute has been greatly expanded. A phased approach has been developed to strengthen the planning, evaluation and implementation of national cancer control activities; and a national goal of reducing cancer mortality by 50% by the year 2000 has been established. The NCI has also created an operations research unit to help perform cost-effectiveness analysis and set priorities for the national cancer control programme. In the USSR, a system of coordinated cancer control services was created after the Second World War and there are almost 3800 oncology units that not only detect and treat cancers but maintain cancer registries and analyse data on cancer incidence, treatment and mortality.

LIMITATIONS OF MODELS AND COST-EFFECTIVENESS ANALYSIS

While it was recognized that the present two WHO models are not the final answer for cost-effectiveness evaluations, they have demonstrated the potential applicability of such an approach and have already led to reallocation of resources in some countries.

There are, however, reservations and limitations in the current models, and some examples of these are given below:

—As this method of analysis does not provide any new empirical observations, it cannot validate the cost-effectiveness of any cancer control activities. The method can only be used to generate inferences from existing information and judgements; the quality of the results will be no better than the quality of the estimates used.

—Setting priorities necessarily requires making subjective judgements, both to estimate parameters and to register preferences for different types of outcomes. This is unavoidable; it is a feature of the problem, not the method.

—Because of a variety of simplifying assumptions, the results of the calculations should only be

considered approximate. No model is perfect: the important point is that the model helps to structure thoughts and to use the available information better than would be possible without the model.

—All models make some structural assumptions. These assumptions should be stated and reviewed for reasonableness. If the assumptions are questionable or uncertain, several models should be built based on different structural assumptions, and their results compared.

—A model is a tool which can be used well or poorly. Its use and value will depend on the skills and open-mindedness of the user.

—Models that try to help people plan for the future must necessarily project trends for the future. There is no way to know in advance if these trends have been predicted accurately; to the extent that the predictions are inaccurate, the projections of the model will also be inaccurate.

—For CANCER*PLAN, the setting of a "target time" and the notion of looking at comparisons in a steady state carries an inborn weakness; as there may not be a steady state, it may be reached at different points in time for different programmes and the build-up towards the steady state may be different in various programmes.

—Although it increases the complexity, the models can consider discount rates other than zero and perform sensitivity analyses to test the results obtained.

—Cost-effectiveness ratios are being utilized for comparative purposes; however, sometimes the denominators of such ratios are not the same or could be judged not to be the same.

—Allowance for the calculation of marginal costs should be given more attention than the above-mentioned examples would imply.

—As costs have been considered solely within the framework of cancer control, the costs of other diseases, which would occur in the absence of cancer (especially high-cost geriatric problems), are not included in the models. Persons responsible for health service budgets should not therefore take as guidelines the estimated costs and savings within cancer control only. However, the existing models provide a valuable tool for allocation of available resources within cancer control and, after modifications, for the allocation of health service resources overall.

CONCLUSIONS AND RECOMMENDATIONS

Principles of cost-effectiveness analysis

Cost-effectiveness analysis helps planners in two main ways: (1) it can help them to determine the least expensive way of accomplishing a particular activity, and (2) it can help them to allocate the available resources for cancer control activities more efficiently in order to attain the overall objective.

Cost-effectiveness analysis involves the following steps:

—Define the objective of the cancer control programme, including all relevant outcomes.

—Identify the possible cancer control activities and the variations that might affect their effectiveness or costs.

—Estimate the effectiveness of each activity (and its variations).

—Estimate the cost of each activity and its variations (including all relevant costs).

—Estimate the marginal return of each activity, compared with its variations. This involves estimating the change in effectiveness caused by a change in costs.

—Activities that have high marginal returns should be given priority over activities that have lower returns.

—Describe all assumptions and value judgments, and explore (through sensitivity analysis) how lack of precision in the data, assumptions and value judgements will affect the results.

The practice of cost-effectiveness evaluation

Practical methods are available today for using cost-effectiveness analysis to help design national cancer control programmes. The World Health Organization and the WHO Collaborating Center for Research in Cancer Policy at Duke University in the USA have developed specific cancer control models for applying cost-effectiveness analysis in practical settings. These models have been tested and found useful in identifying priorities in Chile, India, and the USA.

With cost-effectiveness analysis, priorities can be set across activities involving primary prevention, screening, early detection, treatment, rehabilitation and pain control.

Recommendations

(1) Given the magnitude and importance of the cancer problem in both developed and developing countries, it is essential that the available cancer control resources should be used as efficiently as possible.

(2) To combat cancer effectively with the available resources, it is essential that countries should explicitly define their cancer control objectives, and set priorities for achieving these objectives.

(3) The principal aim in allocating cancer control

resources should be to reduce cancer incidence and mortality, and improve the quality of life of cancer patients. With proper priorities, the existing cancer control resources can be used more efficiently to achieve greater reductions in the number of new cases, as well as suffering and deaths, without increasing the costs.

(4) The participants expressed a strong desire that the use of cost-effectiveness evaluation should be promoted in countries. The methods developed by WHO are available for use today; additional methods, being developed by other groups in other countries, should also be tried out.

(5) Countries may wish to encourage the use of cost-effectiveness evaluation and develop incentives for improving the efficiency with which cancer control resources are applied. Based on the results of cost-effectiveness analysis, countries may want to set new priorities for cancer control.

(6) Health planners should be made aware of and participate in the use of cost-effectiveness analysis for setting priorities.

(7) Programmes should be established to train people to use cost-effectiveness analysis in the design of national cancer control programmes.

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RÉSUMÉ

UTILISATION DES MÉTHODES QUANTITATIVES POUR LA PLANIFICATION DES PROGRAMMES NATIONAUX DE LUTTE ANTICANCÉREUSE

Il est essentiel d'affecter rationnellement, et de manière à avoir un rapport coût-efficacité favorable, les ressources disponibles dans les pays pour la lutte contre le cancer. Si l'on s'en tient aux priorités actuelles, l'incidence et les taux de morbidité et de mortalité du cancer resteront trop élevés. Deux modèles de lutte anticancéreuse d'un bon rapport coût-efficacité, élaborés par l'OMS pour aider les Etats Membres à fixer l'ordre des priorités pour leurs programmes de lutte nationaux, ont été éprouvés et se sont révélés utiles.

Ces deux modèles ont été employés d'une part pour évaluer les stratégies de lutte contre le cancer de la cavité buccale dans les pays en développement et de dépistage du cancer du col de l'utérus, d'autre part pour calculer l'impact de différentes combinaisons de mesures de prévention, de dépistage, de détection précoce, de traitement et de soulagement de la douleur, ainsi que des d'activités d'appui, sur l'incidence et le taux de mortalité du cancer, sur le problème de la douleur et sur les coûts.

Il est donc maintenant possible d'estimer l'efficacité, le coût, le rapport coût–efficacité et le rendement marginal de diverses combinaisons d'activités de lutte anticancéreuse. Ces modèles ont été utilisés au Chili, aux Etats-Unis d'Amérique, en Inde et au Sri Lanka. La description des deux modèles est fournie et leur application dans les pays est indiquée.

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